Association between Body Mass Index and Cardiorespiratory Fitness among Healthy Children of 8-14 Years of Age

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Highlights:

- Association between Cardio-respiratory fitness and body mass index
- Effects of increasing weight and cardio-respiratory function in children

Abstract

Background: Cardio-respiratory fitness is the total capacity of circulatory and respiratory systems to supply oxygen to the skeletal muscles during a physical activity and that can be bothered by increased or decreased weight due to effects of BMI.

Objective: To determine the effect of Body Mass Index on cardio respiratory fitness in children of 8nto 14 years in Lahore.

Methods: A total of 121 children aged 8 to 14 were enrolled in this cross-sectional study. Participants were randomly chosen from Lahore's urban region. The 20-meter shuttle run test was used to determine cardio - respiratory fitness. Body mass index (BMI) was calculated using the formula i.e., BMI = weight (kg)/height (m)2. Height and weight were measured using standard criteria. The participants were divided into four groups based on their BMI (underweight, normal weight, overweight, and obese). The link between BMI and cardio-respiratory fitness has been discovered.

Results: Children who were underweight, overweight, or obese had decreased cardio respiratory fitness, hence BMI was found to be negatively correlated with cardio respiratory fitness. The statistically significant results were found with gender and BMI groups of underweight and normal while non-significant with overweight and obese.

Conclusion: Cardio respiratory function is associated with increased and decreased body mass. Interventions addressing these important effects of physical fitness in this particular population should be implemented.

Key Words: Shuttle run test, Cardio respiratory fitness, Body mass index, Children.

Introduction:

Cardio-respiratory fitness is the potential of the circulatory and respiratory systems to give oxygen to skeletal muscles during continuous physical activity (CRF). Exercising benefits not only the respiratory system but also the heart by uplifting the quantity of oxygen breathed as well as diffusion to the tissues.VO2 max, or maximal oxygen consumption, is the greatest number of oxygen a person can consume during a strenuous or extreme exercise.[1]

Better cardiorespiratory fitness can lower the probability of heart disorder by enhancing the capability of cardio, pulmonary, and vascular system.[2, 3] The less work your heart needs to do in pumping blood through your body, the better. Today's children have poor cardio-respiratory fitness as a result of their sedentary lifestyle. Going out and playing on a regular basis has become increasingly uncommon due to a multitude of causes.[4]

Obesity in childhood has been linked to an increased risk of physical illness, and early mortality in adulthood, according to a growing set of knowledge. However, children who are able to achieve a healthy body weight in childhood have a lower risk of cardiovascular disease than those who remain overweight.[5]

The BMI (Body Mass Index) is a measurement of a person's weight in relation to their height. BMI may be calculated using weight in kilos and height in meters (weight/height in meter square). Underweight, normal weight, overweight, and obese are the four main categories included in this study.[6]

BMI and cardio-respiratory fitness are two interrelated linkages in the health chain. The majority of research shows that individuals with a healthy BMI have adequate cardio-respiratory fitness.[7, 8] As a result, it's apparent that BMI is an important indicator of cardio-respiratory fitness. In order to have enough cardiopulmonary fitness, a person's BMI should be optimal.[7]

Methodology:

The sample size was 121 calculated using Epi tools formula $\mathbf{n} = \frac{\mathbf{z}^2_{\alpha/2}\mathbf{p}(\mathbf{1}-\mathbf{p})}{\mathbf{d}^2}$ in which z2 = level of significance, margin error=d and expected population of variable =P. The BMI was calculated through [BMI = weight (kg)/height (m)2] formula. A wall-mounted tape measure was used to measure height at the nearest 0.1 cm, and an electronic scale was used to measure weight to the nearest 0.1 kg. Using BMI standards given by the International Obesity Task Force, BMI scores has been divided into underweight, normal-weight, overweight, and obese groups. Self-reporting was used to acquire demographic data such as age and grade.

For cardio-respiratory fitness, the 20-meter shuttle run test was used for its assessment. Standardized procedures were followed for the 20-meter shuttle run test. Participants ran 20 meters apart from one cone to the next, keeping time with a pre-recorded beep. Every minute, the beep was increased, and volunteers were instructed to keep up with the beeping for as long as possible. The test stopped if a participant failed to reach the appropriate cone within the allotted time i.e. two times in a row, or if he or she could no longer sustain the pace. The number of shuttles (level) would be kept track of and analyzed.

The SPSS version 23.0 was used for data analysis. Descriptive statistics for age and gender were found out. The association was calculated using chi-square test. The p-value ≤ 0.05 was considered statistically significant.

Results:

A total of 121 participants were recruited in the study in which 44.6% were males and 55.4% were females. The mean age calculated was 11±2.3 years. Table 1 shows the descriptive statistics for age. The histogram for age is presented in figure 1.

Figure I: Descriptive statistics for age

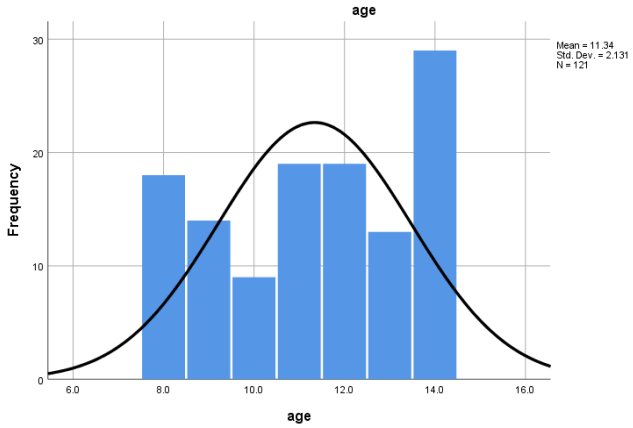

Figure 1: Frequency of age

Table 2 shows the association between BMI and cardio respiratory fitness (CRF) with the descriptive statistics for each group of BMI. The statistically significant results were found with groups of underweight and normal i.e., <0.05. While non-significant results were found in the groups of overweight and obese.

BMI	Frequency	20 m shuttle run test				Total	P-value
		Good: 8-11	Average: 6-9	Poor:4-7	Very Poor: <5-<4		
Underweight	N	0	13	24	4	41	0.01
	Percent MRT	0.0%	48.1%	68.6%	26.7%	33.9%	
Normal	N	43	3	0	0	46	0.02
	Percent MRT	97.7%	11.1%	0.0%	0.0%	38%	
Obese	N	1	9	3	3	20	0.34
	Percent MRT	2.3%	33.3%	20.0%	20.0%	16.5%	
Overweight	N	0	2	4	8	14	0.31
	Percent MRT	0.0%	7.4%	11.4%	53.3%	11.6%	
	Total Count	44	27	35	15	121	
	Cumulative Percent (%) MRT	100.0%	100.0%	100.0%	100.0%	100.0%	

: MRT=Meter run test, BMI=Body mass index

Table 2: **Association between BMI and cardiopulmonary fitness**

Table 3 explains the association between gender and cardio respiratory fitness and shows the significant results.

Gender	Frequency	20 m shuttle run test				Total	p-value
		Good: 8-11	Average: 6-9	Poor:4-7	Very Poor: <5-<4		
Males	N	19	15	15	6	54	0.01
	Percent (%) MRT	40.9%	55.6%	42.9%	40.0%	44.6%	
Females	N	26	12	20	9	67	0.01
	Percent (%) MRT	59.1%	44.4%	57.1%	60.0%	55.4%	
	Total Count	44	27	35	15	121	
	Cumulative Percent (%) MRT	100.0%	100.0%	100.0%	100.0%	100.0%	

: MRT=Meter run test, BMI=Body mass index

Table 3: **Association between Gender and Cardio-respiratory fitness**

Discussion:

Cardio-respiratory fitness was shown to be declining in 8–14-year-old children, particularly in those who were underweight, overweight, or obese. The proportion of individuals deemed "unfit" in both boys and girls increased by roughly 55 percent in females and 44 percent in males. Overweight and obesity prevalence in girls and boys increased in tandem with the COVID pandemic.

Furthermore, not only among overweight or obese children, but also among lean or underweight children, a decrease in cardio respiratory fitness was found over time. Our research found that overweight, underweight, and obese children's cardio respiratory fitness is inadequate, and so is their physical activity, as compared to normal weight children who've been physically active and have adequate cardio respiratory fitness. 97 percent of the children who did well in the 20m shuttle run test had a healthy BMI.

Poor cardio-respiratory fitness has been linked to poor metabolic health and an increased risk of dying young.[9-11] In this study, 8 to 14-year-old boys and girls were shown to have increased body fat and worse fitness levels. It was also calculated that children's fitness has declined by 0.4 percent every year over the last two decades (or 2.4 percent over a 6-year period).[12] According to this study, physically active youngsters had a substantially higher level of cardio respiratory fitness than inactive children. The similar conclusion was reached after observing a group of Spanish children.[13] Direct and short-term physical activity measures have been proven to be less accurate markers of activity level than cardiopulmonary fitness [1]Although our findings cannot be compared to those of other studies since we used alternate methodologies, but could support a suggestion to the government to implement health promotion policies for children that emphasize on cardio respiratory fitness. In children, a relation was observed between aerobic fitness and body fat percentage, but also certain risk factors.[4] Several cross-sectional and longitudinal investigations in youth, [14] including obesity, have found a link between CRF and cardiovascular risk factors.[4, 15] A curvilinear relationship between CRF and health markers was discovered in one study, revealing the health impacts of minor increases in children and adolescents with low fitness

levels.[15, 16]

The aim of this research was to evaluate the relation between BMI and cardio respiratory fitness. In terms of cardio respiratory fitness, we discovered that normal-weight kids performed better on the shuttle run test as comparable overweight and obese counterparts. Lower cardio respiratory fitness has been linked to an increased body mass index in previous studies. [17, 18]

However, poor cardio-respiratory fitness can limit physical activity engagement and loss of muscle strength.[19] Physical exhaustion and a lack of perceived physical competence may have contributed to the overweight and obese children's inadequacy of cardio respiratory fitness in this study. We anticipated that the 20-meter shuttle run test would be difficult for both overweight and obese girls since it demands them to transport their body mass across space.

The study's main strength was that it examined cardio respiratory fitness and body composition over time for a significant proportion of the population of children in a limited age group. We thoroughly tested each child's CRF using 20-meter shuttle run test.

Conclusions:

It is concluded that Body mass index clearly affect person's cardio respiratory fitness. In comparison to their normal-weight counterparts, overweight, obese and underweight girls and boys have lower cardio respiratory fitness.

Recommendations:

The fitness related trainings should be observed. A healthy diet should be manifested in the children.

Acknowledgements: Authors would like to thank all the subjects who gave their time to participate in this research project.

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